REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-3, 5, 7, 9, 11-15, 17, 19, 22-31, 34-38, and 41 are presently active in this case, Claims 29, 35, and 36 amended and Claims 32, 33, 39, and 40 canceled by way of the present amendment.

In the outstanding Office Action, Claims 29, 30, and 35 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,402,847 to Takagi et al.; Claims 31 and 38 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Takagi et al. in view of WO 01/48790 to Komiya et al.; Claims 32, 33, 39, and 40 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Takagi et al. in view of JP 2001/093699 to Ishii and U.S. Patent No. 6,030,486 to Loewenhardt et al.; Claims 36 and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Takagi et al. Claims 29, 30, 34-37, and 41 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ogasawara et al., WO 02/39493, in view of Takagi et al.; Claims 31 and 38 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ogasawara et al. and Takagi et al., and further in view of Komiya et al.; and Claims 32, 33, 39, and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ogasawara et al., Takagi et al., Ishii, and Loewenhardt et al.

Turning now to the merits, Applicants' invention is directed to an exhaust ring for a plasma processing apparatus. Such exhaust rings are positioned around the periphery of the substrate and have a plurality of holes through which process gasses are exhausted from a plasma area to a non-plasma area of the plasma processing chamber. As discussed in Applicants' specification, prior art exhaust rings were problematic in that they allowed plasma to "leak" into a non-plasma region of the processing chamber, thereby reducing the plasma density at a peripheral region of the substrate to be processed (and more generally

reducing uniformity of plasma characteristics).[1] While attempts have been made to address these problems by reducing the overall area of the through holes in the exhaust plate, such a design undesirably reduces the vacuum exhaust efficiency of the plasma chamber.[2] Applicants disclosed invention is directed to addressing these problems.

For example, as seen in the embodiment of the present invention shown in the vertical sectional view of Fig. 15, exhaust holes (314a, 314b, 314c) penetrating the exhaust ring (focus ring 306) are circular holes each of which extend linearly, and have a diameter which is substantially constant from the upper end of each exhaust hole to the lower end thereof. However, the diameter (opening area) of a hole is smaller at positions toward a center region of the exhaust ring, while the diameter of the holes gradually increases at positions toward the outer peripheral region of the exhaust ring. That is, in the example of Fig. 15, the opening areas of the exhaust holes satisfy the following size relationship: 314a < 314b < 314c. In such a manner, those three types of exhaust holes having different opening areas are arranged concentrically in three rows. As discussed in Applicants' specification, this arrangement allows reduced plasma leakage, while maintaining an acceptable exhaust efficiency.

Further, as seen in Fig. 16 of Applicants' specification, magnets 350 are provided on the exhaust ring to prevent leakage of plasma, and the thickness of the exhaust ring 313 can be made smaller than in the case where no magnet is provided. Thus, as a whole, the conductance of the exhaust ring 313 can be improved, as compared with the case where the magnets 350 are not provided. In addition, a magnetic field is produced by the magnets provided at the exhaust ring, and causes charged particles in the plasma to turn, and collide against the inner walls of the exhaust holes 314a, 314b and 314c, thereby preventing leakage of the plasma. Claims 32, 33, 39 and 40 are directed to covering these embodiments. The

[1] Applicants' Specification at p. 3, lines 13-23.
[2] Applicants' Specification at p. 3, lines 23-31.

cited references do not disclose these features in combination with the linear through holes and varying hole sizes discussed above.

In order to expedite issuance of a patent in this case, Applicants have amended independent Claims 29 and 36 to clarify the patentable features of the present invention over the cited references. Specifically, Applicants' Claims 29 and 36 recite that the exhaust ring has a plurality of exhaust holes that extend linearly and are arranged in concentric rows such that opening areas of the exhaust holes vary from one concentric row to another to increase from an innermost one of the concentric rows to an outermost one thereof. Thus, the conductance is improved (for example double) over the case where exhaust holes have the same diameter. Furthermore, in general, the greater the diameter of the exhaust hole, the larger the amount of leakage of plasma. In order to impede (or prevent) such leakage of plasma, the amended claims recite a magnetic field acting in the circumferential direction, which is generated by magnets provided in the exhaust ring.

In contrast, the primary reference to Takagi et al. is directed to a baffle plate having a prolonged life before deposits are able to close off holes in the baffle plate. As discusses in the Amendment filed April 12, 2007, since the slits of Takagi et al. are tapered (the opening area of the air-intake side of each slit is different from that of the exhaust side), Takagi et al. does not disclose a plurality of exhaust holes that extend linearly (i.e., not tapered) as required by independent Claims 29 and 36. As also previously discussed, Takagi et al. also does not disclose that the plurality of exhaust holes which extend linearly are concentrically arranged in three rows, and the rows are different in opening area of the exhaust hole from each other such that the opening areas of the exhaust holes gradually increase from the inner peripheral side of the exhaust ring toward the outer peripheral side thereof. Still further, Takagi et al. does not provide any disclosure of the recited magnetic fields.

In Ishii and Loewenhardt et al., leakage of plasma is not prevented, and magnets are provided in walls of a chamber such that a magnetic field generated by them acts in the radial direction of the chamber, in order to seal the plasma in the chamber. In contrast, in the present invention as recited in amended claims 29 and 36, magnets are arranged so that a magnetic field generated by them acts in the circumferential direction of the chamber. By virtue of the arrangement of the magnets, plasma ions and electrons are caused to turn about a line of magnetic force, and collide against inner walls of the exhaust holes, thereby preventing leakage of plasma. Ishii and Loewenhardt et al. do not disclose this feature, and the generated magnetic field of the invention (and advantage thereof) is not disclosed in these references.

In Komiya et al., in connection with the relationship between the exhaust path and pressure, exhaust rings are formed to have the same diameter, in order to uniformize the amount of exhausted gas. Therefore, the structure of Komiya et al. is different from the structure taught in each of the amended Claims 29 and 36, which is intended to improve the exhaust conductance, and prevent leakage of plasma. In addition, Komiya et al. does not disclose a technique in which magnets are provided in the exhaust ring, and leakage of plasma is prevented.

Finally, Ogasawara proposes a technique in which an exhaust ring is formed to have through holes and convex and concave portions, thus restricting leakage of plasma and an abnormal discharge. Therefore, Ogasawara is clearly different from the present invention in concept, result, method and structure. Further, there is no discussion in Ogasawara of the magnetic field feature of Applicants' claims 29 and 36.

For the reasons discussed above, Applicants' independent Claims 29 and 36, as amended, patentably define over the cited references. As Claims 30, 34, 35, 37-38 and 41 depend from Claims 29 or 36, these claims also patentably define over the cited references

Nevertheless, Applicants dependent claims further remove the claimed invention from the cited prior art.

Claims 31 and 38 recite that the exhaust ring has a plate thickness that varies concentrically. Fig. 15 of Applicants' specification shows an embodiment covered by these claims. As seen in this figure, the exhaust ring is formed in a stepwise manner such that a thickness of the exhaust ring gradually increases from the inner peripheral side of the ring in which exhaust holes having the smallest diameters are formed, toward the outer peripheral side of the ring in which exhaust ring having the greatest diameters are formed. In Komiya et al., the ring is formed to a uniform thickness over the ring. Thus, contrary to the position taken in the Office Action, the structure of Komiya et al. is different from the structure taught in Claims 31 and 38.

As is clear from the above, the amended Claims 29 and 36 and the sub-claims depending thereon each recite an exhaust ring which can improve the exhaust conductance such that it is double those of conventional exhaust rings, and can also prevent leakage of plasma. They are different from the references in method for solving the problems. Accordingly, the present invention cannot be easily derived from the references and any combination thereof even by a person with ordinary skill in the art.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application and the present application is believed to be in condition for formal allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

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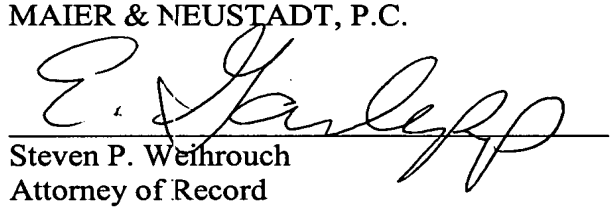

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